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REPORT OF THE GENETICIST FOR THE YEAR 1934-35.

BY

A. E. S. McINTOSH, B.Sc., Ph.D.,

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SECTION I.

SUGAR CANE.

A. SUGAR CANE BREEDING, SEEDLING SELECTION AND TRIALS.

(i) *Sugar Cane Breeding—B.37' Series.*

Sugar cane breeding was carried out at Lion Castle estate during October, November and December, 1934. The technique employed in the breeding work has recently been described in detail in a separate publication.*

The sex of fifty-six varieties, employed as parents for the first time, was determined. Of these the following are perhaps of general interest:—

Variety.	Sex.
D. 625	Strong. ♂
B.6450	Strong. ♂
B.6835	Strong. ♂
Bourbon	♁
Synthetic Kassoer	♁
Kassoer	♁
Saccharum spontaneum (local Coimbatore form) ..	Strong. ♂
Hathooni	♁
Hemja	♁
Uba (Indian)	♁
Uba (Hawaiian)	♁

The extent and nature of the crossing work is shown below:—

(a) Crosses between "noble" varieties (*Saccharum officinarum*).	
(1) between Barbados varieties	18
(2) between Barbados and imported "noble" varieties	2
(b) Cross between Barbados variety and *Saccharum spontaneum* (Coimbatore form)	1
(c) Crosses between Barbados varieties and *Saccharum spontaneum nobilisations* (Kassoer and Toledo)	
(1) second nobilisation	3
(2) third nobilisation	4
(3) fourth nobilisation	26
(4) fifth nobilisation	7
(d) Crosses between Barbados varieties and *Saccharum barberi.* (Hemja and Hathooni)	2
Carried forward	63

* McIntosh, A. E. S., 1935.—An account of the Policy and Methods Employed in the Breeding and Initial Stage of Selecting Sugar Cane Seedlings.—B.W.I. Central Sugar Cane Breeding Station.—Bull. No. 6, pp., 4–12.

Brought forward	63
(e) Crosses between Barbados varieties and *Saccharum barberi* nobilisations (P.O.J.'s 213, 234, 2379 and Co.213).	
(1) second nobilisation	3
(2) third nobilisation	2
(f) Crosses between Barbados varieties and *Saccharum sinense* (Uba)	2
(g) Crosses involving *Saccharum officinarum*, *S. spontaneum* and *S. barberi* blood	7
	77

The following new crosses, included in the above summary, are of interest:—

(a)
(1) Ba.11569 x D.625.
(2) Ba.11569 x B.6450
„ x B.6835
Bourbon x B.H.10(12)

(b)
Ba.11569 x *Saccharum spontaneum* (local Coimbatore form).

(c)
(1) Synthetic Kassoer x B.H.10(12).
Kassoer x B.H.10(12).

(d)
Hathooni x B.H.10(12).
Hemja x B.H.10(12).

(e)
(1) Co.213 x Burke.
P.O.J.213 x B.2935.

(f)
Uba (Hawaiian) x B.H.10(12).
Uba (Indian) x B.2935.

(g)
Co.213 x P.O.J.2878.

(ii) *Seedling Raising and Planting Out—B.37' Series.*

The usual procedures were followed for collecting and sowing the arrows and fuzz and making germination counts.

The following new and considered important crosses proved to be highly fertile:—

Ba.11569 x Burke.
„ x B.6450.
„ x B.6835.
„ x D.625.
Bourbon x B.H.10(12).
Ba.11569 x *Saccharum spontaneum* (local Coimbatore form).

The following were of average fertility:—

Uba (Hawaiian) x B.H.10(12).
Uba (Indian) x B.2935.
Kassoer x B.H.10(12).
Synthetic Kassoer x B.H.10(12)
Co.213 x P.O.J.2878.

The following were of poor fertility:—

P.O.J.213 x B.2935.
Co.213 x Burke.
Uba (Hawaiian) x P.O.J.2878.

The following produced no seedlings:—

Hemja x B.H.10(12).
Hathooni x „

The fourth and fifth nobilisations of Java *Saccharum spontaneum* were highly fertile.

The cross, Ba.11569 x Co.281, proved to be highly fertile this season, while the cross Ba.11569 x Co.290 gave very poor germinations.

The seedlings were potted during January and February, 1935. Pottings were allocated as follows:—

A. Proven Crosses (All are crosses between Barbados varieties which have been shown, by experiment, to produce seedlings of high standard).

Number.	*No. of Seedlings Potted.*
5	7,216.

B. Semi-proven Crosses (These are crosses which have not yet been tested or tested insufficiently, but which are considered distinctly promising as producers of good seedlings. All are crosses between noble varieties).

Number.	*No. of Seedlings Potted.*
7	4,016.

C. Experimental Crosses (Trial Marriages).

(a) Crosses between noble varieties.

Number.	*No. of Seedlings Potted.*
7	1,247.

(b) Nobilisations.

(i) Chunnee (*S. barberi*).

2nd degree.

Number.	*No. of Seedlings Potted.*
2	192.

3rd degree

Number.	*No. of Seedlings Potted.*
2	219.

(ii) Uba (*S. sinense*).

1st degree.

Number.	*No. of Seedlings Potted.*
2	165.

(iii) *S. spontaneum* (local Coimbatore form).

1st degree.

Number.	*No. of Seedlings Potted.*
1	254.

(iv) *S. spontaneum* (Tabongo—North Celebes form).

2nd degree.

Number.	*No. of Seedlings Potted.*
1	154.

3rd degree.

Number.	*No. of Seedlings Potted.*
2	152.

(v) *S. spontaneum* (Glagah—Java form).

2nd degree.

Number.	*No. of Seedlings Potted.*
2	262.

3rd degree.

Number.	*No. of Seedlings Potted.*
2	500.

4th degree.

Number.	*No. of Seedlings Potted.*
19	3,179.

5th degree.

Number.	*No. of Seedlings Potted.*
7	1,240

(vi) Nobilisations incorporating blood of several *Saccharum* species.

Number.	*No. of Seedlings Potted.*
5	1,185

A summary of the above details is given below:—

Group.	*Number.*	*No. of Seedlings Potted.*
Proven Crosses	5	7,216
Semi-proven Crosses	7	4,016
Experimental Crosses.		
(i) between noble varieties ..	7	1,247
(ii) nobilisations	40	7,502
Totals	59 64	19,981

In general, it may be stated that noble cane breeding is intended to provide seedlings for areas in the British West Indies which possess good growing conditions and are free from major diseases, higher degrees of nobilisation are intended to provide seedlings for areas with good growing conditions but dominated by some major disease (e.g. mosaic), while the lower degrees of nobilisation are being made to provide seedlings for (a) areas with poor soil conditions and (b) use as parent plants in further nobilisation schemes.

An important alteration in the testing of first year seedlings, which was envisaged last season, was carried into effect with the above seedlings. The alteration and the reasons for it were described in a footnote on page 6 of The Report of the Geneticist for the Year 1933-34.* Briefly, the seedlings are now transplanted from the pots into a *field nursery* where they will be grown until November of this year and the majority replanted then for a test lasting until the crop of 1937. There will therefore be no B.36' series of seedlings. The field nursery chiefly provides planting material for a November planting, although it is the intention to effect a minor elimination in the nursery prior to planting in first year trials. It is hoped that this nursery stage may be unnecessary should fuzz storage tests show that it is practicable to obatin the necessary number of seedlings by storing fuzz and sowing it in July so that potted seedlings are ready for planting in November.

The field nursery was planted during March and April, 1935. The plants were spaced closely and inserted in small cane holes (three of these being made in the length normally occupied by one cane hole).

* Agri. Journ., Dept. Sci. Agri., Barbados. Vol. 3, No. 4, October, 1934.

The seedling populations were kept distinct in blocks: otherwise no special layout was employed. Planting allocations in the field nursery are noted below.

Group.	No. of Crosses.	Approximate Number Planted.
Proven crosses	5	6,200
Semi-proven crosses	7	1,750
Experimental crosses.		
(i) Crosses between noble varieties	3	180
(ii) Nobilisations.		
(a) *S. barberi*	4	313
(b) *S. sinense*	2	160
(c) *S. spontaneum* (local Coimbatore form)	1	230
(d) *S. spontaneum* (North Celebes form)	3	235
(e) *S. spontaneum* (Java form) ..	27	2,610
(f) derived from blood of several *Saccharum* species	4	545
Total	56	12,223

At the November planting approximately 10,000 seedlings will be planted at the normal cane hole spacing and by a layout essentially similar to that employed during recent years in first year seedling tests. It will therefore be possible at this stage to eliminate approximately 2,200 seedlings. The features for elimination,—always having in mind the special purposes of individual crosses —will be (1) cane width and to a lesser extent (2) number of canes.

(iii) *Results of Reaping First Year Seedlings—B.35' Series.*

These seedlings were bred in 1933, planted out in April, 1934 and reaped during the crop of 1935.

As in 1934, there were three distinct groups:—

(1) Proven Crosses—Early Group.
(2) „ „ —Late Group.
(3) Experimental Crosses (Trial Marriages).

The first group was reaped in February, the second in May and the third in March.

For each of these groups and for subsequent seedling trials, a detailed account will be published in the near future as a Bulletin of the British West Indies Central Cane Breeding Station, as to the layouts employed, the methods of and reasons for seedling selections. For the first year seedlings these have already been outlined in the Report of the Geneticist for the season 1933-34. (Agri. Journ., Dept. Sci. Agri., Barbados, Vol. 3, No. 4, 1934, pp.7-9).

The final selections are noted below.

A. Proven Crosses.

(i) Early Group.

Cross.	*Number Selected.*
Ba.11569 x S.C.12/4	26
Ba.11569 x B.417	22
Ba.11569 x Ba.8069	5
*B(30)L6 x B.H.10(12)	4**
*B(30)L6 x S.C.12/4	6**

(ii) Late Group.

Ba.11569 x B.H.10(12)	20
Ba.11569 x Ba.6032	7
Ba.11569 x B.603	17
Ba.11569 x B.606	3
Ba.11569 x Ba.8069	1

All these selections, with the exception of those noted in the footnote (**), were retained and multiplied in their respective groups.

These selections are retained for further trials in Barbados.

B. Experimental Crosses.

(i) Crosses between noble varieties.

Cross.	*Number Selected.*
†Ba.11569 x B.H.10(12)	4
„ x B.376	1
„ x B.694	2
„ x Burke	2

These selections were transferred for further tests to the proven cross selections (q.v. above).

(ii) Nobilisations.

(a) Nobilised Java *Glagah*. These are mostly nobilisations of the 4th and 5th degree, and represent crosses between Java commercial varieties and Bardos varieties and back-crosses of seedlings derived from these to Barbados and Java (P.O.J.2878) varieties. They are thick cane seedlings suited to better soil conditions and a large percentage of them is probably commercially resist-

* B(30)L6 is a seedling resulting from the cross P.O.J.2364 x B.391.

** These selections, for purposes of further trial, were transferred to the group comprising nobilised seedlings selected from the experimental cross group (q.v. B(ii) below).

† Seedlings comprising a population of this cross are randomised in the experimental cross group to serve as a standard population for comparison with the populations of the experimental crosses.

ant to mosaic disease. In this category *forty-three* seedlings were selected from a total of *seventeen* crosses.

(b) Seedlings derived from thin cane parents. Their canes tend to thinness. They are probably hardy and suited to poor soil conditions. A considerable percentage may possess resistance to froghopper and mosaic disease.

These selections are noted here.

Cross.	*Number Selected.*
Toledo x S.C.12/4	12
Co.213 x B.391	3
„ x B.H.10(12)	1
B.3215 x Co.281	2
P.O.J.213 x B.H.10(12)	1

(c) Selections intermediate in type between (a) and (b).

Cross.	*Number Selected.*
Ba.11569 x Co. 290	16
„ x P.O.J.234	8
„ x Co.281	3

In all *ninety-nine* nobilised seedlings were selected. These are now being multiplied for a second year trial in Barbados during the season 1935-37. Prior to planting in November 1935, selections will be made in their multiplication plots so that approximately 40—50 will be tested in this second year trial.

At reaping, the usual field data was obtained for every seedling in the experimental cross group and sucrose per cent. in juice determinations made for an adequate sample of seedlings from each population. From this data, the usual sets of tables—as exampled in previous reports—were made.

(iv) *Notes on Seedlings Constituting the B.34' Series of Seedlings.*

These were selected in the first year trials reaped in 1934. Selections were made from early and late reaped proven crosses and from experimental crosses. In all, ninety-five *noble cane crosses* were selected. These were put into multiplication plots at Codrington during the spring of 1934. By the crop season of 1935, the multiplication plots of the early group selections had grown sufficiently to warrant taking field and sucrose data for each seedling.

During November 1934, all the selections from noble cane crosses were planted in twenty-four cane hole plots at Dodds station. These plots serve (1), to provide sufficient planting material for comprehensive trials of those eventually selected, (2), to test resistance to gumming disease * and, (3), to effect elimination of obviously poorer seedlings.

For the early group, the field and laboratory data obtained at Codrington in 1935, and, for both groups, the field and gumming disease resistance data

* Gumming disease resistance tests are described in detail in Bulletin No. 8 of the B.W.I. Central Sugar Cane Breeding Station.

obtained at Dodds during 1935 serve to eliminate some of the seedlings. The remainder will be planted in routine second year trials for season 1935-37.

One of these seedlings, i.e. B.3439, looked so promising in the multiplication plots at Codrington that it was promoted direct to the routine second year trials of the B.33' series of seedlings (q.v. section (v) below).

Fifty-two *nobilised* seedlings were selected from the experimental cross group. These represented various degrees of nobilisation, by Barbados varieties, of several wild *Saccharum* species.

These were placed in multiplication plots at Codrington during 1934 and observations made on their growth and appearance throughout the year.

During the planting season in November 1934, they were allocated as follows:—

(1)	for second year trial at Codrington Experiment Station	34
(2)	for parent material in breeding plots at Lion Castle.....	36
(3)	for tests of resistance to gumming disease at Dodds	52

The object of this second year test is to find out, for the thirty-four seedlings, how they perform in field and factory over the average British West Indies growing season. Those which come up to or better the performance of the Barbados standard noble variety (B.2935) in this trial will be despatched for further trial, after quarantine in the Central Plant Quarantine Station in Trinidad, to considered appropriate areas in the British West Indies.

(v) *Notes on Seedlings Constituting the B.33' Series of Seedlings.*

These were selected as first year seedlings during the 1933 crop. The *nobilised* seedlings selected then were used for breeding purposes and for tests on the inheritance of gumming disease.

The *noble* seedlings underwent the routine multiplication and minor selection tests described for the corresponding group of the B.34' series (q.v. section (iv).)

The final selections made in November 1934, both early and late groups, were planted in second year trials at Dodds (low rainfall station) and Todds (high rainfall station).

(vi) *Second Year Seedling Trials—B.32' Series. (Late Group).*

The *early* group of this series was reaped in 1934. (See explanation for this in the Report of the Geneticist, Agri. Journ., Vol. 3, No. 4, 1934, pp. 10—11).

The late group second year trials contained thirteen seedlings. These were tested against the appropriate standard varieties at Dodds (low rainfall station) and Todds (high rainfall station) during season 1933—35. The layout, the methods of reaping, selecting and statistically analysing the results were essentially similar to those employed in previous years' second year trials.

Two seedlings were selected for further trials, i.e., B.3259 and B.3267. Both were derived from the cross—Ba.11569 x B.H.10(12).

The following short notes are made for each.

B.3259. The canes are above average number, of good length and average width and yield a good tonnage under higher rainfall conditions. The juice quality was high. This seedling will be tested in the intermediate and higher rainfall districts.

B.3267. The canes are below average number but individually of excellent appearance, being long and thick and remaining sound. Tonnages were good, more especially at the higher rainfall station. The juice quality was below average. This seedling will be tested over a range of conditions experienced over the low-intermediate to higher rainfall districts.

As customary for selections from the second year trials, these seedlings will be tested in select seedling trials and maturity experiments. Their growth will be recorded in the latter.

(vii) *Select Seedling Trials.*

(a) *Plant Canes*—B.31' *Series.*

These trials were designed to test second year selections of the B.31' series, i.e. B.3124, B.3125, B.3127, B.3138. In addition, the earlier seedlings,—B.2977, B.3011 and B.3013 were included for further test. The standard varieties used in trials appropriate to each were—B.2935, Ba.11569, B.726 and B.H.10(12).

Six stations were selected to represent the various soil and climatic conditions. These were:—

(1) Haymans—Sandy coral limestone soil, low rainfall.
(2) Oldbury—Shallow black coral limestone soil, low rainfall.
(3) Frere Pilgrim—Shallow black coral limestone soil, low—intermediate rainfall.
(4) Buttals—Deep valley black coral limestone soil, low-intermediate rainfall.
(5) Woodland and Guinea—Shallow red coral limestone soil, intermediate-high rainfall.
(6) Cottage—Shallow red coral limestone soil, high rainfall.

At each station, two contiguous trials were planted—one for early, the other for late reaping.

FIG I.

SELECT SEEDLING TRIALS

Plant Canes — Early Reaping

Saccharose in thousands of pounds per acre

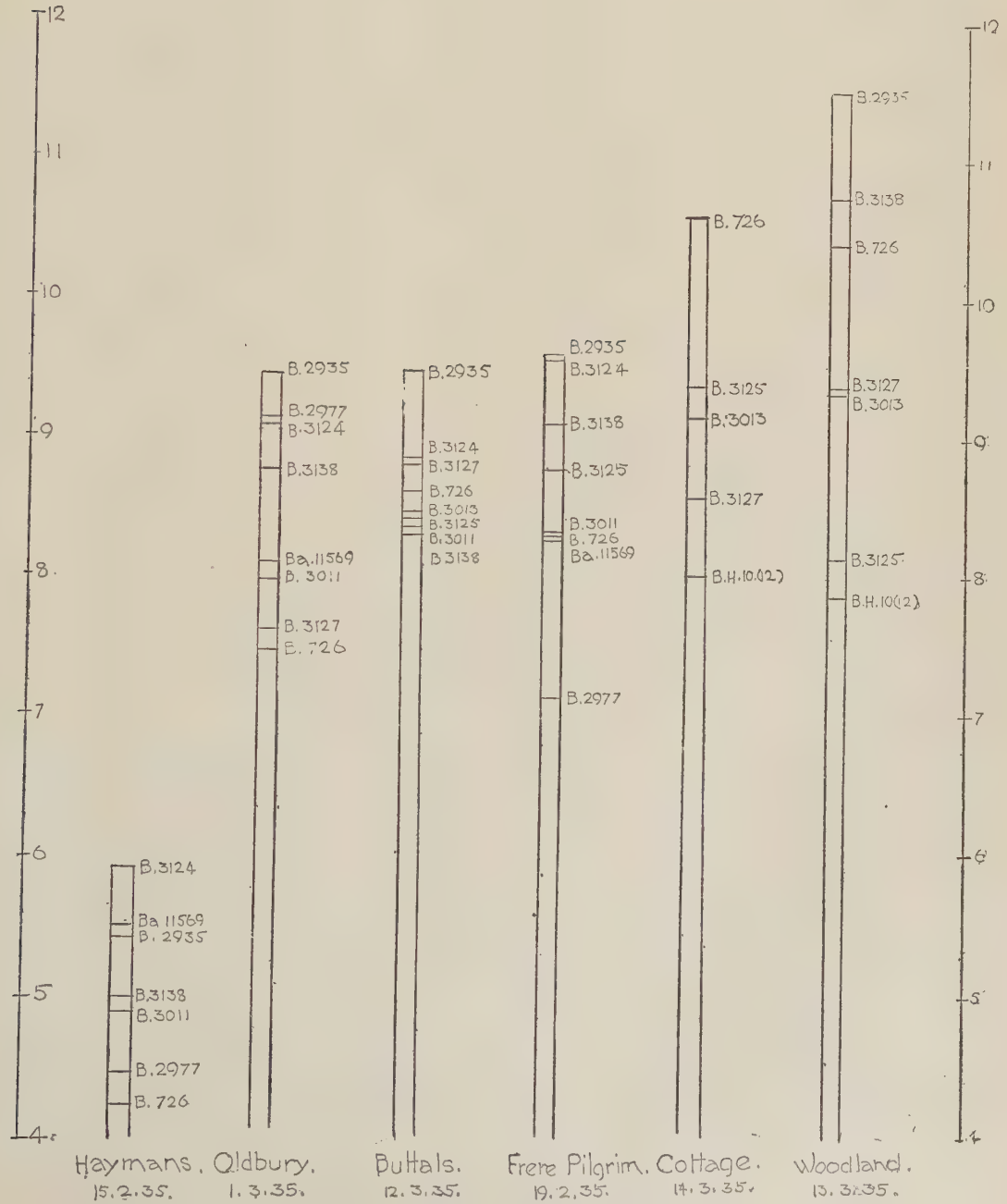
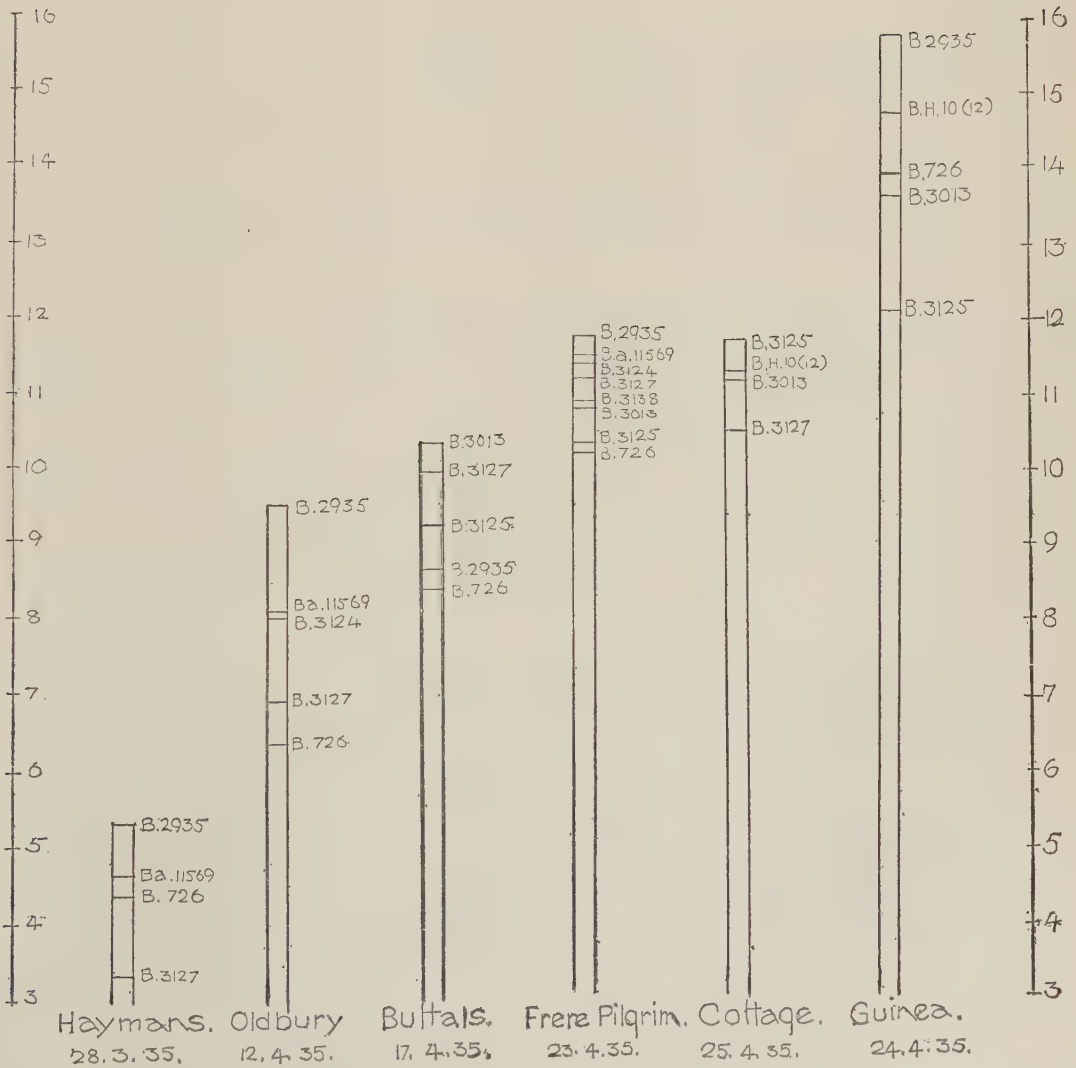


FIG II

SELECT SEEDLING TRIALS.

Plant Canes. Late Reaping.

Saccharose in thousands of pounds per acre.



General Observations on Rainfall During the Season 1933-35.

The rainfall during the early months of the rainy season in 1934 was reasonably good. The rainfall during October and November, however, was extremely low and threatened to ruin part of the crop in the lower-rainfall district. Good rains fell during December and January (1935) and served to revive the crop to an appreciable extent.

The rainfall shortage during October and November served to depress the yields of all varieties but more especially the long season types. The varieties are listed here in the order in which they may be said to have suffered from these low rains—B.H.10(12), B.3013, B.726, B.2935, Ba.11569.

The retardation of growth during October and November and the good rains later caused a late growth.

This late growth was responsible for a late maturation, particularly in the higher-rainfall districts. At the same time, it was also responsible for the comparatively low percentage of rotten cane experienced at reaping.

Comments on the Trials. From a statistical point of view all the trials, with one exception, were satisfactory. The exception was the early reaping at Cottage. A statistical analysis of this trial indicated that little or no reliability could be placed on its results.

The late reaping at Guinea—an estate near to Woodland—was made to serve as a late reaping for Woodland. This was done on account of its being impracticable to obtain a field large enough to accommodate both time-of-reaping trials on the latter estate.

Results of the Trials. A summary of variety and seedling yields of saccharose per acre is presented in diagrammatic form in Figs. I and II.

Comments on the Results of the Trials. In considering the results, the effect of the very low October and November rains on the several varieties and seedlings must be kept in mind.

In general, all the seedlings showed up well against the standard varieties and would appear to render difficult making finite conclusions on each. Their growth, however, was recorded throughout the year and in addition each was reaped in the maturity experiments. With all the data on hand, the following notes are appended both for varieties and seedlings.

B.2935 This new standard variety excelled practically in all trials. The exceptions were the early reaping at Haymans and the late reaping at Buttals. Under conditions represented by Haymans, it is possible that it may be bettered as an early variety by a seedling with somewhat fewer canes per stool and better early juice qualities e.g. B.3124. In the deep valley soils as represented by Buttals—it tends to rot towards the end of crop.

The high returns recorded by B.2935 at the intermediate-high rainfall stations—Woodland and Guinea—are not surprising in a low-rainfall year. Previous trials have shown that this variety tends to rot readily in a season of average rainfall in districts represented by these stations and it would be unwise to plant it on any appreciable scale in such districts.

Ba.11569. The season under review was more favourable to the growth-type of Ba.11569 than to that of B.2935. In spite of this, the latter variety is seen to be better than Ba.11569 in five out of six trials. B.2935 is undoubtedly a better plant cane variety than Ba.11569. Ratooning is considered in subsection (b) of this section and in section (viii) below.

B.726 This variety is severely penalised by rainfall shortage during the rainy season. This shortage was especially marked at the lower-rainfall stations. As a result, B.726 yielded relatively poorly at these stations. In these trials it was chiefly intended to serve as a standard for the early reaping. On account of the unfavourable season it has failed in this purpose at the lower-rainfall stations. In view of the fact that B.726 is liable to suffer in a poor rainfall year and that B.2935 ripens rather later in crop, it is evident that an early ripening seedling is required in Barbados for the lower-rainfall districts.

B.726, on the other hand, performed very well at the higher-rainfall stations. Owing to the late growth of the season, its usual late crop rotting was little in evidence.

B.H. 10(12). This variety suffered particularly as a result of the low rainfall. It is a long season variety requiring a long and sustained rainy season. It undoubtedly made much growth during December, January and February and was very green when reaped. As a result it was very immature at the early reapings and gave very low sugar returns. At the late reapings it had ripened and yielded very well. It is undoubtedly best to plant both B.726 and B.H.10(12) in the higher-rainfall areas; the former to provide ripe canes early in crop.

B.2977. This seedling germinated badly and yielded irregularly. It is now discarded.

B.3011. This seedling was tested as an early seedling for lower and lower-intermediate rainfall conditions. It germinates well and grows evenly. The cane number is above average, but the canes tend to thinness. It does not promise to yield so well as B.2935 and is therefore discarded.

B.3013. This seedling shows considerable promise. Growth measurements and maturity experiments have shown it to have a length of growing season intermediate between B.726 and B.H.10(12). Its canes are of average number and length but of variable width. They remain remarkably sound during crop and weigh well. They are easily reaped. The juice quality is very high. Indications from its trials are that it shows considerable promise as an intermediate crop variety in the higher-rainfall district, a late crop variety in the intermediate rainfall district and more especially in the deep valley soils. This seedling has been planted in variety trials (q.v. section (viii)).

B.3124. This seedling is essentially suited as an early cane under lower-rainfall conditions. The number of canes per stool is average. The canes are long and of average width. They rot readily if kept for any length of time during crop. The juice quality is high early in crop.

This seedling gives a certain amount of promise as an early variety for a restricted area in the lower-rainfall shallow black coral limestone and sandy coral limestone soils. It is being multiplied for test against B.2935 and B.726 in variety trials in these areas during 1935—37.

B.3125. This seedling is suited essentially to early reaping, in intermediate—and higher-rainfall areas. It possesses considerably above the average number of canes per stool and thus appears to be unable to withstand prolonged dry conditions. The canes are of good width but have a short season growth. As a result, they ripen early but rot readily. The juice quality is very high. It is essentially a competitor of B.726 and B.3013 but it is doubtful if it will better these. It has been re-included in Select Seedling Trials for season 1934—36.

B.3127. This seedling possesses an average number of canes per stool. The canes are long and of good width. They, however, root heavily at the nodes and thus make reaping difficult.

This seedling does not appear to come up to commercial standard. It has, however, been re-included in Select Seedling Trials for season 1934- -36.

B.3138. This is an unusual type of Barbados seedling. The growth habit very much resembles that of P.O.J.2878. It is difficult to germinate and considerable computation had to be made at reaping to establish its tonnages. As a result its yield figures cannot be considered very reliable. The cane number is average. The canes are very variable in width and length. It does not appear to be promising but is re-included in the Select Seedling Trials for season 1934-36.

(b) *First Ratoons.—B.29' and B.30' Series.*

Two of the plant cane select seedling trials of season 1932-34 were cut as ratoons in 1935.

These were:—

Small Ridge—Shallow black coral limestone soil, low-intermediate rainfall.

Bowmanston—Shallow red coral limestone soil, intermediate-high rainfall.

For each plot, the yield of cane and number of dead canes were ascertained.

The yields are presented in Table I.

TABLE I.

Station.	Variety and Yield in Tons Per Acre.				
	Ba.11569	B.2935	B.726	B.H.10(12)	B.3013
Small Ridge ..	24.55	26.24	22.09	—	22.00
Bowmanston ..	—	35.63	33.85	28.96	33.86

The chief object of these reapings was to furnish contributory evidence as to the ratooning powers of B.2935 and B.3013. The variety B.2935 is regarded chiefly as a competitor of Ba.11569 in the lower and lower-intermediate rainfall districts. In this respect, the result at Small Ridge shows that it performs satisfactorily. This aspect will be further considered below in Section (viii), subsection (b).

The seedling B.3013 is competing essentially with B.726 over a range of conditions from intermediate to high rainfall. In the above trials it compared well with B.726, and in view of its being much easier to cut and less susceptible to rotting, it gives promise of displacing, at least in part, the variety B.726 as a commercial variety in these districts. It has been planted in an extensive series of variety trials for season 1934-36. (See Section (viii) subsection (a) below).

(VIII.) *Variety Trials.*

(a) PLANT CANES.

The nature of the recently instituted co-operative variety trials in Barbados has been described in detail in the Report of the Geneticist for season 1933-34 (Agric. Journ. Dept. Sci. & Agri., Vol.3, No. 4, 1934, pp.15-22).

The trials completed during crop 1934 indicated that two seedlings—B.3013 and B.3234—were sufficiently promising to warrant inclusion in variety trials.

Results up to that date suggested that those seedlings were promising for the conditions noted below.

B.3013. This seedling would appear to be best suited to early reaping in the low-intermediate rainfall areas, to late reaping in the valley soils; to early and mid-crop reaping in intermediate and higher rainfall areas.

B.3234. This seedling would appear to be best suited to late reaping in the intermediate-high and higher rainfall areas; i.e. it appears to be directly competing with B.H.10(12).

To test those indications thirteen stations were chosen. These were chosen as follows.

Conditions.	*Number of Stations.*
High rainfall, shallow red coral limestone soils	3
Intermediate-high rainfall, shallow red coral limestone soils	4
Intermediate rainfall, shallow red coral limestone soils	3
Low-intermediate rainfall, deep valley black coral limestone soils	1 (two trials on one station).
Low-intermediate rainfall, shallow black coral limestone soils	2

In the last category noted above, B.3013 is being tested against B.726 and B.2935 for early reaping in crop.

In all other stations each trial comprises the following—B.726, B.H.10(12), B.3013 and B.3234.

These trials will be reaped during crop in 1936.

(b) First Ratoons.

In season 1932-34, a series of plant cane trials was carried out to test the then seedling B.2935 as a plant cane against Ba.11569, B.726 and B.891 in the low and low-intermediate rainfall district. These were reported in detail in last season's report (q.v. reference above). It was concluded that B.2935 was the best plant cane variety for these districts.

It was desirable to test its ratooning ability under these conditions, since a certain amount of ratooning is done in these areas.

Four of the trials were cut as ratoons in 1935. The results are noted in Table II.

TABLE II.

Station.	Variety and Yield in Tons Per Acre.			
	B.2935	Ba.11569	B.726	B.891
Ridge	28.61	..	23.67	20.65
Edgecumbe	24.88	28.15	25.05	..
Bourbon	15.13	15.70	..	11.51
Bulkeley	25.48	..	25.26	25.79

The conditions for ratoon springing during the crop of 1934 were unusually severe; the rainfall being persistently very low during the dry-season months. It would appear, from observations made, that B. 2935 does not shoot so readily under severe conditions as Ba.11569 and B.726. Under less severe dry-season conditions it shoots readily and yields well as a ratoon (c.f. results of trials at Small Ridge and Bowmanston, Section (vii) and results of this series at Ridge).

In view of its high yield of plant cane over the conditions under review here and its satisfactory yield as a ratoon it would appear to be the best variety for commercial planting.

In the deep valley soils it is still doubtful if it is better than B.726 where both plant cane and first ratoon crops are grown. The yields of B.726 in these soils appear to be more consistent than those of B.2935. B.726 is moreover a better factory variety. Further field trials are necessary to determine the comparative merits of B.726 and B.2935 in these soils, prior to making finite recommendations.

Planting recommendations to individual estates will follow in the main those made prior to last planting season. The area to which Ba.11569 will be recommended will, however, be appreciably smaller, while B.2935 will be recommended to dominate in the low-intermediate rainfall areas.

B. A SHORT NOTE ON SPECIAL INVESTIGATIONS.

As noted in the Report of the Geneticist for season 1933-34, page 2, special investigations will be described in detail from time to time in separate publications. An outline progress report of these for the season under review, is presented elsewhere. (Agri. Journ., Dept. Sci. & Agri., B'dos., Vol. 4, No. 2, April, 1935, pp.77-81).

These are:—

(1) Maturity Experiments.
(2) Growth Measurements.
(3) Root System Investigations.
(4) Gumming Disease Investigations.
(5) Sugar Cane Fuzz Storage Experiments.
(6) Experiments with the Zeiss Hand Refractometer.

Detailed accounts of Growth Measurements* and Root System Investigations† have already been published. A detailed account of the Gumming Disease Investigations since 1929 up to season 1933-35 is now in print and will be published in the near future‡

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* McIntosh, A. E. S., 1934 .. .. Sugar Cane Growth Measurements in Barbados. Agri. Journ., Dept. Sci. & Agri., B'dos, Vol. 3, No. 1, pp. 1-29.

† Stevenson, G. C. & McIntosh, A. E. S., 1935. Investigations into the Root Development of the Sugar Cane in Barbados. (1) Root Development in Several Varieties under one Environment.—B.W.I. Central Sugar Cane Breeding Station, Bulletin No. 5.

‡ McIntosh, A. E. S. & Stevenson, G. C., 1935. Gumming Disease Investigations in Barbados.—B.W.I. Central Sugar Cane Breeding Station, Bulletin No. 8.

SECTION II.

SWEET POTATO.

A. VARIETY TRIALS.

(i) Catch-Crop Trial, 1934.

The catch-crop trial was conducted at Balls plantation, the time allowed for the crop being seventeen weeks.

Six seedlings of the series raised in 1928 were tested against the standard varieties Red Nut and V. 52.

The layout was four randomised blocks and the plot size forty cane holes (=approximately 1/30 acre). Three hills were made to each cane hole and two slips (cuttings) planted in each hill.

At digging the yield and number of potatoes per plot were ascertained.

The yields are noted in Table I.

TABLE I.

Variety or Seedling	Mean Yield of Potatoes Per Plot lb.	Statistical Note.
B.5	345.8	A difference between variety plot means of ± 42.7 lb. of potatoes may be regarded as significant
B.13	332.3	
B.44	331.5	
Red Nut	326.5	
B.6	321.5	
B.9	304.3	
V.52	288.3	
B.11	244.3	

A *cooking* test was carried out for each seedling. The following notes were made for each cooked sample by seven disinterested judges—(1) colour of flesh, (2) texture, (3) flavour. Finally each judge was invited to give an opinion on the cooking quality of each. B.5, B.6, B.44 and B.9 were adjudged to possess good cooking quality, B.11 and B.13 indifferent or poor cooking quality. The seedlings were also subjected to a *storage* test.

(ii) Long-Crop Trial. 1934-35.

This was carried out at Ellesmere plantation and lasted for twenty-five weeks.

The same seedlings were tested as in the above catch-crop trial.

The layout and field data taken were essentially similar to those in the catch-crop trial. The standards were Black Rock, V.52 and Red Nut.

The yields are presented in Table II.

TABLE II.

Variety or Seedling	Mean Yield of Potatoes Per Plot lb.	Statistical Note.
Red Nut	259.5	
B.44	257.8	A difference in mean yield of potatoes per plot of ± 42.4 lb may be regarded as significant.
B.6	215.5	
V.52	215.0	
B.13	212.5	
B.5	204.6	
B.9	182.3	
Black Rock	150.5	
B.11	118.4	

A *cooking* test was made for each seedling.

(iii) Recommendations for Planting on a Commercial Scale.

Seedlings from the series raised in 1928 have been undergoing trials against standard varieites every season up to the present.

It is worthy of note that, despite every precaution taken in selecting sites, laying out and planting experiments, the comparative performances of varieties and seedlings vary in different trials.

In assessing the value of any seedling in the field a review of its performance throughout all its trials was made. In addition, each was subjected to at least three distinct cooking and storage tests.

The following seedlings of this series are recommended for planting as varieties on a commercial scale in Barbados—B.5, B.6, and B.44. The features of each are noted below.

B.5. Potatoes. Skin pink and smooth, uniform spindle in shape, flesh white, borne fairly close to the surface and easily dug: on cooking, flesh is tinged slightly green, of a dry and floury texture and sweet: in storage, keep reasonably well.

General. This variety yields exceedingly well under catch-crop conditions and has potatoes of attractive appearance. It is recommended as a catch-crop variety to replace, at least in part, Red Nut and Six Weeks.

B.6. Potatoes. Skins pale reddish purple, with a tendency to corrugation, flesh white, borne fairly close to the surface and easily dug: on cooking, flesh is creamy white, slightly moist and fairly sweet: in storage keep reasonably well.

General. This variety yields well under catch-crop conditions. It is recommended for conditions similar to B.5.

B.44. Potatoes. Skin deep reddish purple, smooth and uniform spindle in shape, flesh white, easily dug: on cooking, flesh is tinged light grey, slightly moist in texture and sweet: in storage, keep well.

General. This potato yields very well, especially under long-crop conditions. It is recommended as a long-crop variety to displace Black Rock.

Slips of these varieties will be available from the Department of Science and Agriculture during the present rainy season.

These two variety trials conclude the tests of the first series of seedlings raised in 1928. The above three seedlings will in future be regarded as commercial varieties and included in future trials as standards.

B. SEEDLING SELECTION AND TRIAL—SECOND SERIES.

These were conducted to test the second series of seedlings raised in 1932.

(i) Catch-Crop Series, 1934.

A trial to test this series was carried out at Codrington and represented the third season of test of this series of seedlings. Twenty-eight seedlings were tested against the standard varieties—Red Nut and V.52.

The layout was four randomised blocks and the plot size fifteen cane holes (=c.1/125 acre). The trial lasted for approximately sixteen weeks.

At digging the following data was obtained for each plot:—number and weight of potatoes and number of potatoes destroyed by scarabee (*Euscepes batatae*).

Field selections were based on weight and appearance of potatoes and flesh colour. Fourteen were selected in the field.

These were subjected to cooking tests. As a result of the cooking test four were eliminated. The remaining ten were promoted to the catch-crop variety trial for 1935.

(ii) Long-Crop Series, 1934-35.

This series was tested at Golden Ridge plantation. It included seedlings selected from the second season's long-crop seedling test at Pickering's plantation. The trial lasted approximately twenty-four weeks.

The lay out and methods employed in taking data at digging were the same as in the above trial. The standard varieties employed were Red Nut, V.52 and Black Rock. Twenty-four seedlings were tested.

A cooking test was carried out on field selections. Twelve seedlings were finally selected for tests in the 1935-36 long-crop variety trial.

THE EFFECT OF CLIMATIC CONDITIONS ON DIATRAEA SACCHARALIS.

By

R. W. E. TUCKER, M.A., B.Ed.

There is at present some uncertainty as to the effect of general climatic conditions, especially of prolonged low rainfall, and of normal or abnormal rainfall, on the prevalence of, and damage caused by *D. saccharalis* in cane.

Observations which have been made in Barbados on extent of egg deposition, percentge parasitism by *Trichogramma*, rate of larval survival and period of maximum emergence of moths in a year of good rainfall (1933) and a year of prolonged low rainfall (1934) may therefore be of interest.

The records given in the following pages show that continuous egg counts in experimental blocks of cane, both colonised and uncolonised, indicate clearly that the rate or extent of parasitism by *Trichogramma* is adversely affected by prolonged low rainfall. This, as will be shown, agrees with experimental findings on the effect of reduced humidity on *Trichogramma*.

The year 1934, therefore, saw reduced efficiency on the part of *Trichogramma* due to prolonged low rainfall, to a reduction in numbers of *Trichogramma* liberated (due mainly to insect parasites and predators in the breeding units), and to a partial mistiming of liberations, due to the fact that, as will be shown, the main hatchings of *D. saccharalis* occurred subsequently to the cessation of breeding and liberation of *Trichogramma*.

It is reasonable to expect under the above circumstances that moth borer damage would show an increase in the 1934 crop, when reaped in 1935.

It must be pointed out, however, that abundance of *D. saccharalis* and extent of damage due to this pest, must not be confused. The usual criterion of abundance of *D. saccharalis* in Barbados is the number of plant cane stalks bored, and the percentages of joints or internodes which are found bored in extensive samples of plant cane taken each year at crop reaping period. Obviously, in a year of drought, there are fewer cane stalks per acre, and fewer and smaller joints per stalk; there is also less tendency for the shorter, lighter cane stalks to break in two and become a total or partial loss due to borer, but a greater tendency for the slowly growing canes to have their 'growing points' bored and destroyed. These factors tend to produce a higher general stalk infestation, which would be shown in factory estimates, and a lower field loss, as shown by the routine counts of canes killed by borer. An understanding of the effect of climate conditions on both *D. saccharalis* and its host plant is of importance in the measurement of damage, and the assessment of any control measure against this pest. A standard method of measuring damage, or pest prevalence, or both, is obviously essential if results in different countries are ever to be compared.

The complicated nature of the *D. saccharalis* problem has often been referred to, and the writer has no wish to make it appear more complicated than is

necessary by gratuitously introducing 'climatic effects'; but it is of no use to ignore the data which has been obtained by two years of field examination, under widely different climatic conditions, of the various mortality factors affecting this pest.

It is claimed that in Barbados proof has been obtained of a reduction in damage due to *D. saccharalis*, and that this reduction can only be attributable to the mass liberation of *T. minutum*.

At the same time it is well known that climatic conditions have some effect on the abundance of, and damage caused by, *D. saccharalis* but, as stated in the first paragraph, there is much uncertainty as to the true effect of climatic conditions.

The following records and observations are an attempt to make some progress towards understanding the mechanism whereby one factor such as low rainfall over a critical period affects the *D. saccharalis-Trichogramma-host* plant complex.

The pest is affected, the parasite is affected, and the host plant and growth thereof is affected; the writer makes no claim to have solved or evaluated all the various actions and interactions, but desires to make a contribution which may help towards an eventual solution or evaluation.

The fact that *Trichogramma* is shown to be adversely affected by a year such as 1934 in Barbados does not reflect on the position which the writer has assigned to it as a controlling factor over *D. saccharalis* in Barbados.

The effects of climatic conditions on *D. saccrahalis* in Barbados are likely to be most marked in respect of:—

(a) rate or extent of egg deposition:

(b) rate of larval mortality:

(c) effectiveness of *Trichogramma minutum* and other parasites or predators which affect the total real mortality of *D. saccharalis*:

(d) alteration on the life cycle period of *D. saccharalis*.

Climatic conditions affect all of the foregoing factors, and each in turn affects one or more of the others. Each of these factors is therefore discussed in detail below.

Rate of Extent of Egg Deposition.

It is of interest to examine the conditions which affect egg deposition by *Diatraea*, in order to ascertain whether it is possible to correlate egg deposition with the known factors which affect it, and with control measures against *Diatraea*.

Three phases of fluctuation in egg deposition have to be considered, namely local fluctuation in numbers laid, monthly fluctuation, and annual or total fluctuations.

Local Fluctuations. These are due to:—

(a) situation of cane field (hill top, hill side, valley or plain).

(b) local average rainfall, wind velocity and temperature:

(c) vigour and density of cane growth

(d) variety of cane:

(e) proximity of sources of *Diatraea* infestation during the first 4 or 5 months of growth.

Monthly Fluctuations. There is normally a seasonal curve of extent of egg deposition by *Diatraea,* increasing monthly with the growth and density of shoots of the cane, and increasing with rainfall on which this growth depends. This curve starts from a low level in January each year and normally reaches a peak in September or October (in Barbados). This normal curve can be altered considerably by the majority of the above conditions, but particularly weather conditions, which cause local fluctuations.

Annual Fluctuations. These depend primarily upon annual climatic conditions, i.e. excessive or badly-distributed rainfall, normal rainfall or drought, and the accompanying differences in wind velocity and temperature, inasmuch as these factors influence rate of larval survival, effectiveness of parasites, growth of cane, and possibly fecundity of *Diatraea* moths. They depend secondarily upon the effectiveness of control measures which are at present in force against *Diatraea,* and possibly thirdly upon any considerable change over from one variety of cane to another variety of different borer susceptibility. The most that can be done to measure the extent or rate of *Diatraea* egg deposition is to study intensively throughout the year as many plots of cane of adequate size that resources permit, and to sample as extensively and as often as possible the general condition of the whole of the cane area in question.

The results of examinations and records of egg deposition in plots of one variety only, and in randomised plots of different varieties made in Barbados in 1934 have produced interesting data, particularly in respect of cane variety and egg deposition, which may or may not be applicable to other areas. The field sampling of egg deposition,, though carried out on a large scale, can hardly, it is now realised, be made extensive enough to correct errors due to the above-mentioned local, monthly and annual fluctuations.

The data thus obtained has some positive value, however, despite the obvious difficulties in ascertaining the effect of one factor only, namely the effect of prolonged low rainfall on *Diatraea* egg deposition, owing to the presence of the other factors mentioned, namely rate of larval mortality, effectiveness of *Trichogramma* and other parasites or predators, and life cycle period of *Diatraea,* all of which are influenced by prolonged lack of rain, and in turn influence prevalence of moths and therefore egg deposition.

Rate or extent of egg deposition is, therefore, difficult to correlate directly either with climatic conditions or with the results of any control measures, and the most that can be done at present is to outline, as above, the factors which bring about fluctuation in egg deposition.

Rate of Larval Mortality.

The monthly plot records carried out in 1934 show higher rates of larval mortality, particularly from July onwards, than those recorded for 1933. It is presumed that the difference is due to the prolonged deficiency of rainfall in 1934.

TABLE I.

LARVAL MORTALITY OF D. SACCHARALIS IN B.726 AT CODRINGTON.

Month.	1933.	1934.
	Per cent.	Per cent.
January ..	97.34	100.00†
February ..	97.80	100.00‡
March	92.59	95.53
April	88.20	93.50
May	92.90	95.15
June	89.50	90.08
July	85.50	82.66
August ..	0.00*	70.66
September ..	15.70	77.16

Effectiveness of Trichogramma minutum and other Parasites or Predators which exert some control over Diatraea.

The records for 1933 and 1934 show clearly that in most months natural parasitism for 1934 was very much below the corresponding records for 1933; there appears to be no reason for this other than prolonged shortage of rain.

* These are plot records, and it would appear to be a fact from field observations as well as plot records such as this, that at times and in some places, larval mortality is 0.0 per cent and survival is 100 per cent.

† On January 15th a living larva was found in the January plot, but, as it was nearly fully grown, was not counted as coming from eggs laid in the plot in January.

‡ In the February plot when reaped two dead hearts were found, but neither larval nor pupal cases were found. In both months, therefore, mortality from eggs laid in these plots is given as 100 per cent.

TABLE II.

PARASITISM BY TRICHOGRAMMA IN EXPERIMENTAL PLOTS OF B.726 AT CODRINGTON IN 1933 (WET) AND 1934 (DRY).

Month.	1933. Uncolonised.	1934. Uncolonised	1934. Colonised.
	Per cent.	Per cent.	Per cent.
January ..	0.83	7.80	..
February ..	8.00	7.60	..
March	6.10	7.10	8.30
April	11.55	3.40	15.50
May	31.92	6.96	11.30
June	32.88	11.60	27.50
July	18.75	25.20	57.40
August ..	32.84	22.00	51.20
September ..	52.04	14.30	31.80

Two months in 1934 appear to be exceptions, namely January and July, in each of which the parasitism is considerably higher than for 1933. Actually they are not exceptional, but illustrate the effect of other factors as described elsewhere in this paper. Thus, the experimental block of 12 plots of cane in 1934 had a field of ripe cane immediately alongside of it, and extending along one half of its length, both *Diatraea* and *Trichogramma* would be expected to migrate from the ripe cane into the field of new growth, and this is shown by extent of parasitism by *Trichogramma* and to a certain extent by egg deposition. The experimental block in 1933 had no such plot in contact with it, and as stated in (4) artificial colonisation with *Diatraea* was resorted to in order to establish a workable population. The field of ripe cane adjoining the experimental block in 1934 was cut down early in February, which is reflected to some extent in Tables I and IV, and illustrates the conditions which tend to be set up by ripe cane adjoining at various distances and for various periods (until reaped) the fields of young growth of the succeeding crop.* Concerning the July records, Table IV shows that July 1933 was a month of very low egg deposition in the experimental plots, which, following a similar low deposition in June, would, in turn, adversely affect the rate of parasitism for that month. At the same time, rainfall records at Codrington show that July 1934 was the best of a series of poor rainfall at that period, and that by comparison with July records for 1933, rain fell on 11 days and 18 nights in 1934, giving a total of 3.35 inches, whereas in 1933 rain fell on 17 days and 18 nights giving a total of 7.07 inches. The highest day totals were .83 inches in 1933 and .44 inches in 1934, and the highest night totals were 1.15 inches in 1933 and .39 inches in 1934. The improved rainfall for July 1934, together with the higher egg deposition for that and the preceding month, are considered as accounting for the natural parasitism of eggs in 1934, being the highest and most normal figure for the 1934 series.

*In 1935 owing to the late incidence of rain in 1934, crop reaping was not started until an average of 4 or 5 weeks later than usual. *Some* of the young cane fields in 1935 were therefore exposed for a correspondingly long period to infestation from ripe cane, and showed, in consequence, an increase in dead hearts indicative of a more prolonged and therefore greater infestation.

Table I, therefore, shows the reduction in effectiveness of *Trichogramma* in 1934 compared with 1935, and, in the writer's opinion, the reduction in the efficiency of *Trichogramma* in 1934 is connected with the prolonged low rainfall during the months of liberation in that year.

In support of this, laboratory experience in the rearing of *Trichogramma* has shown frequently that high temperature and insufficient humidity react far more to the detriment of *Trichogramma* than to the laboratory host *Sitotroga*. This is confirmed by the work of H. O. Lund (1) on "Some Temperature and Humidity Relations of Two Races of *Trichogramma minutum* (Riley)" both races being those used or experimented with in Barbados, namely the Grey Louisiana race and the yellow California race.

Briefly stated, Lund's findings are that the period of development of *Trichogramma* in the host egg bears an inverse relation to relative humidity, and that mortality of both host and parasite, but *particularly of the parasite.*, increases with decrease in humidity; and that mortality of the parasite also increases at both extremes of temperature. Also, the mortality of the parasite within the egg varies much more widely with temperature and humidity than does mortality of unparasitised eggs. Thus one would expect that in prolonged dry weather such as experienced in 1934, *Trichogramma* would be far more adversely affected in the field than its host *Diatraea*, and that its period of development would be lengthened, and its mortality rate increased.

That this would appear to be actual fact is shown by the very low percentage of parasitism recorded for 1934 in Table I.

It is possible that the undoubted lessening of the effectiveness of *Trichogramma* both in its natural and colonised states is connected with the lack of diminution in egg deposition noted in the experimental plots of Codrington in 1934 compared with 1933 (Table IV) when *Trichogramma* was presumably more effective, and was moreover liberated in greater numbers for that year.

In addition to a diminution in the effectiveness of *Trichogramma* in killing eggs of *Diatraea*, there is a big difference in the mortality of *Diatraea* eggs caused by the predators described in (4). As stated in the latter paper, it was found during the course of bi-weekly counts of all eggs laid in experimental plots, that many egg clusters were eaten out and destroyed by a predator, and that, as Psocid larvae were seen on two or three occasions to leave and vanish rapidly from partly damaged egg masses, it was concluded that these insects were the predators. Another predator in the form of a Gamasid mite, *Atomus* sp. was repeatedly taken in the act of sucking *Diatraea* egg masses, and records were kept of all eggs damaged by these two predators in 1933 and 1934.

In 1934, however, the experimental plots were mulched from the beginning with a thick dressing of megass and it is noteworthy that in these plots no *Atomus* were ever caught sucking *Diatraea* eggs, as in the unmulched plots of 1933, nor were egg masses with characteristic *Atomus* found. This is understandable in view

of the fact that *Erithraeidae*, to which *Atomus* belongs, are soil inhabiting mites, and are therefore most probably inhibited by soil mulching.

The difference in percentage of eggs destroyed by predators in 1933 and 1934 is shown in the following Table III. Some of the difference may, in part, be due to drought, but most is undoubtedly due to the suppression of *Atomus*.

TABLE III.

DIATRAEA EGG DESTRUCTION DUE TO PREDATORS IN B.726 PLOTS AT CODRINGTON.

Month.	1933.	1934.
	Per Cent.	Per Cent.
January ..	14.6	12.4
February ..	8.7	11.1
March	32.2	12.0
April	34.0	10.8
May	23.8	10.3
June	22.0	9.1
July	29.1	16.0
August ..	40.2	15.6
September ..	4.3	13.9

Experiments will be carried out in 1935 to give direct comparison between mulched and unmulched blocks of cane in order to determine as far as possible the true rôle played by *Atomus* and whether mulching suppresses this predator.

The benefits to cane growth which follow early mulching of the soil have been conclusively demonstrated in Barbados, and are considered by the writer in the light of present knowledge to outweigh the suppression of the predator *Atomus*, if such suppression is eventually proved.

Nevertheless the point promises to be an interesting one as showing the relations which undoubtedly occur in many pests between agricultural practice and pest prevalence.

ALTERATION IN THE LIFE CYCLE PERIOD OF D. SACCHARALIS.

Interesting information has been obtained during the drought of 1934 on what appears to be an alteration in the normal cycle of *D. saccharalis* caused by prolonged dry weather.

Up till May 1934, dead hearts were very scarce in the majority of fields of young plant cane in Barbados, and when, in June and July onwards, planters were asked to send in supplies of dead hearts or bored shoots to the Department, the response was poor, and many plantations stated that they could find no bored shoots. Subsequently, when distributing fertile *Lixophaga* flies bred on *Diatraea* larvae obtained from the above shoots, the writer found that the fields

picked out by estate managers, etc., as being those worst infested by borer were, with a few exceptions, very moderately infested.

There was every indication, therefore, that, up to the end of July and beginning of August, the amount of borer appeared to be below normal.

It was found, however, that the dissection of bored shoots, in order to obtain living *Diatraea* larvae on which to rear *Lixophaga*, brought some interesting facts to light.

On the writer's return from Antigua in the last week of June, 1934, it was found that not only were there very few *Diatraea* larvae accumulated for the projected *Lixophaga* work, but that the majority of those which had been obtained and placed in jars to feed and develop, had pupated, though only a little over half grown. The scarcity of *Diatraea* larvae accumulated was explained by those in charge of this work as due to the fact that the majority of bored shoots sent in contained *living pupae*, and that such larvae as were obtained pupated rapidly on being disturbed.

This was found by the writer to be the case when large scale dissections of dead hearts were organised for obtaining *Diatraea* larvae; living pupae were far in excess of larvae, and many larvae pupated soon after being disturbed, though not fully grown.

The significance of this, and its connection with the abnormally low rainfall up to that period was not at first appreciated, and it was not until the second week in July that records were kept of all living larvae and pupae found.

Nevertheless the second week in July showed 1,708 living pupae against 1,534 living larvae. After that the proportion gradually became more normal (possibly on account of a moderate rainfall which started at that period) and subsequent weekly records for July show 1,633 pupae and 2,346 larvae, and 1,433 pupae and 2,201 larvae.

The weekly records for August were: 1,485 pupae, 2,708 larvae: 1,000 pupae, 2,370 larvae, 617 pupae, 2,532 larvae, 757 pupae, 2,672 larvae and for two weeks in September 614 pupae, 1,514 larvae and 681 pupae, 2,907 larvae.

In view of the fact that so far as the writer's experience goes, it is usual to find at least five or six times as many living larvae as living pupae, and occasionally ten to twenty times as many, it is obvious that the conditions found in June and the first half of July are quite abnormal, and that even in August and September, the proportion of living pupae to living larvae is still above normal. In addition there was the undoubted fact that the *Diatraea* larvae when removed from the shoots in which they were feeding, frequently pupated within a few hours of removal, and without feeding or developing further in the jars of food to which they were transferred. This behaviour is also not normal, and can quite possibly be ascribed to the abnormally dry weather, for the two conditions described tend to prevent too great an emergence of moths under rainless conditions, and yet enable extra emergences when more favourable conditions arise.

This, then, may account for the low incidence of borers noticed in the field up to August, and for the appearance of a considerable amount of *fresh* borer damage in October onwards, by which time mass production and distribution of *Trichogramma* had ceased.

There remains one more point for investigation and comment, namely extent of *Diatraea* egg deposition. The normal expectation would be that dry weather conditions would decrease egg deposition, partly because moths in general appear to be less fecund under very dry conditions, and partly because of the higher mortality rates for larvae, shown in Table I, yet we find that comparisons of experimental plot records for 1933 and 1934 show that after a lower start in numbers of eggs per acre in 1934, (save for January for which see Table IV). deposition drew level in May 1934 and from then onwards monthly deposition of eggs for 1934 was greater than in 1933.

TABLE IV.

Egg Deposition per Acre in Experimental Plots of B.726 at Codrington in 1933 and 1934.

Month.	1933.	1934.
January ..	4,744	5,713
February ..	14,118	12,733
March	24,022	8,891
April	20,105	10,581
May	7,485	20,643
June	2,108	19,349
July	2,408	12,194
August ..	5,192	9,093
September ..	8,010	13,925
October ..	6,968	42,359

The other records given in this paper show, however, that the climatic factor is not the only factor affecting egg deposition by *Diatraea*.

It has been shown in Table II that the effectiveness of the egg parasite *Trichogramma minutum* has been seriously diminished by climatic conditions in 1934, thus making this factor much less effective in its control over *D. saccharalis*. Moreover, this drawback was made more serious by the fact that the majority of mass reared parasites were put out under these adverse conditions, and that by the time a slight improvement in rainfall took place, the output of parasites was decreasing to cessation point for that season. Also by the fact that production of parasites in 1934 dropped, from various causes, to just over 90 millions.

It has also been shown (Table II) that there is a strong probability that the efficacy of the egg predator *Atomus* has been considerably diminished by mulching the soil in cane fields early in the year; a practice which, owing to

the proved benefits resulting from it, is being more and more widely adopted throughout the Island. This would also tend towards an increase in the prevalence of *D. saccharalis*, but both the above factors are partly counter-balanced by the increased larval mortality shown in Table I.

It is not possible at the present state of our knowledge to evaluate the effect of these variable factors on prevalence of *Diatraea* and extent of its egg deposition, or on the extent of damage caused by *Diatraea*, but it is common knowledge that in the case of insects, and in particular those of long establishment and adaptation to their host plants, factors tending to cause excessive rises or falls in population usually cancel each other, so that only on rare occasions does a failure of some factor or factors cause a temporary catastrophic outbreak or virtual disappearance of the insect. The fluctuations which usually occur are limited and may not be serious.

Possibly, if the field data already obtained and published or recorded is extended in scope and continued for adequate periods in any *D. saccharalis* area, the true effect of climatic conditions on this insect and its various complexes, may be more clearly understood. The foregoing records and observations on the effect of prolonged low rainfall on *D. saccharalis* indicate that the crop reaped in 1935 will show an increase in borer damage as measured by joint or internode infestation, but a slight decrease in actual field loss of cane.*

As one cannot regulate or anticipate periods of prolonged low rainfall, experiments cannot be planned for them, and it may be years before similar conditions occur again, and comparable experimental results obtained.

These records and deductions are given therefore, not as conclusive or final, but as a step towards the better understanding which it is hoped may be eventually reached, of the effect of climatic conditions on *D. saccharalis* in cane.

In conclusion, it must be stated that there is no evidence as yet known to the writer to show that the initial or final population level of *D. saccharalis* is permanently decreased by any of the factors enumerated, including increasing the level of parasitism of *Diatraea* over a period of around six months of the entire cane growth period. There is every indication, however, that late or early reaping of the crop has a decided influence on the initial infestation of the young canes.

It has been shown that the *Trichogramma* factor, whether normal or artificially increased, is only one of several factors which affect the prevalence of *D. saccharalis*, and it is not a simple matter to show conclusively that the reduction in damage to canes which is apparent (from general and experimental evidence) to follow an increase in the real mortality of *Diatraea* due to increased egg parasitism during six months of critical cane growth is apparent in all other

* This has proved to be the case for percentage joint infestation rose from 13.4 in 1934 to 17.0 in 1935, whilst field loss diminished from 10.11% to 9.38% of the cane as standing in the field.

The balance, on the whole, would indicate a rise in infestation by *D. saccharalis* in 1935, due in part to the effect of prolonged low rainfall, as stated in this paper, and in part to the reduction in numbers of *Trichogramma* liberated, and *of damage done to the crop.*

phases of the *Diatraea* cycle. With the partial control so far obtained, and with the various factors involved, there is bound to be lack of complete correlation between the control measure and all phases of the *Diatraea* cycle; but this does not alter the fact that six successive years of field determination of *Diatraea* damage have shown that each year's seasonal reduction in damage, due to *Trichogramma* liberations, has produced worth while results.

There is also some reason for considering that the effect of climatic conditions on the parasites and predators of *D. saccharalis,* including *Trichogramma,* is, next to total larval mortality and late or early reaping of crop, among the most powerful factors in determining the prevalence of *Diatraea,* and there is also little doubt that climatic conditions, in reducing or increasing the amount of cane available for damage, considerably affect the extent of damage recorded for any year.

Reference has frequently been made to climatic conditions: to variations in the weather: to wind, rain, heat and drought on *D. saccharalis,* but none of the references has been as precise as could be wished. The difficulties of being precise on these points are well set out in (1) and (5), and the discussions on these papers in the publications cited.

It was indicated then (1929) that the ideal of co-operative research between entomologists and meteorologists in order to obtain a greater exactness in our understanding of insect relations and adaptations to habitat and responses to changes in climate, or to weather fluctuation, was ten years ahead of its time.

The realisation of the necessity for a more intimate understanding of meteorological changes on insects still remains, but progress is still slow. An attempt was made by the writer to obtain continuous records of temperature and humidity in a canefield, to compare with records external to a canefield, and a generalisation of the method, equipment and results has been given in (6). The work has not been continued, because for real accuracy in measuring small differences the instruments should be kept constantly tested and adjusted, and should, it is imagined, keep pace in position with the cane leaf growth, in which egg deposition and larval hatching occurs, and not be fixed in position the project would then be in itself a complete piece of research work for which adequate time and funds were not available.

Nevertheless, though precision is much to be desired, a generalisation of the conditions under which the problem of *D. saccharalis* control is being investigated may not come amiss.

This paper has given some indication of the effect of prolonged dry weather on rate of *Diatraea* larval mortality, and on rate of parasitism of *Diatraea* eggs by *Trichogramma*: also on effect of dry weather on *Diatraea* egg predators (complicated, however, by soil trashing or mulching) and effect of prolonged dry weather on the *Diatraea* life cycle and seasonal periodicity.

It has been pointed out in (1) that climate and weather are quite different, the latter being obviously a more local condition; and it is surprising how widely local weather conditions can vary even in so small an area as Barbados.

D. saccharalis, however, seems able to tolerate a wide range of both climatic and weather conditions, for it exists from the Argentine and Peru in South America, throughout the Caribbean area, and as far northwards as Louisiana in North America. It is, moreover, one of the few major insect pests which does not vary to great extremes in its incidence; that is to say, although it has years of greater or lesser abundance, it never diminishes to vanishing point in any one year or series of years, to re-appear in devastating swarms in other years—possibly because the cane plant is one which does not get out of relation to the insect, in that there is never an abnormal shortage or abundance of the food plant, and possibly because *D. saccharalis* is, for about two-thirds of each individual existence, sheltered in the safe environment of a cane stalk interior.

As has been pointed out by the writer (5), the biological complexes of *D. saccharalis* vary considerably in different sugar cane areas of North and South America and the Caribbean area, and one can only suppose that the fact that widely different *D. saccharalis* parasitic complexes exist in these different areas is because the parasites are more susceptible to climatic variations than is their host, or because the relationship between parasite and host necessary for the successful existence of the former is easily disturbed.

It is considered by Myers (3) that fluctuations in meteorological conditions, particularly of temperature, have less effect on the biology of insects in the moist tropics than in temperate zones: for, as he points out, the effects of meteorological conditions are most marked in the Arctic regions, diminish with progress through more temperate and warmer climates, and can be considered as exerting their minimum influence in the moist tropical zones. For these reasons, he considers that the interchange of parasitic insects, with particular reference to those of *D. saccharalis*, offers a most promising field in the moist tropics.

As Uvarov (7) has pointed out, very little indeed is known concerning the interaction of meteorology with insect physiology and biology in the tropics, and it is possible that the statements made by De Gryse (1) that "It has been "shown experimentally that variations in temperature, amounting to not more "than 4 or 5 degrees Fahrenheit, may decidedly affect the rate of development "and the behaviour of insects" and the conclusions of Uvarov (7) that "a num-"ber of cases have become known in which factors normally keeping an insect "species down are almost entirely of meteorological order" may not be applicable to the range and scope of *Diatraea*, more especially those in the Caribbean areas.

It must be pointed out, however, that in biological control, one is not dealing with the actual survival potentialities of any introduced insect so much as with its relation to a host insect in a new area, and this relation may quite possibly be more easily interfered with by apparently slight meteorological differences in the moist tropics than is at present suspected. As Uvarov (7) points out, "relatively small differences in the activity range of the host and "the parasite and their rate of development as affected by temperture may "become a deciding factor in the abundance of both insects." Other factors in addition to temperature, such as moisture, rate of evaporation, barometric pressure, etc., may also vitally affect the relation between parasite and host.

Therefore, though the writer has put forward no precise measurements of microclimate, and can do no more than utilise years of widely different rainfall in the manner set out in this paper, the contributions thus made to the effect of meteorological conditions on a long established tropical pest and its biotic environment may help towards later progress in the understanding of this complex problem.

Theoretically, the influence of microclimate on the relationships between parasite and host should be investigated before the collecting, transferring and establishing a parasite for the purpose of biological control is undertaken; actually, however, it is often cheaper and far more interesting to obtain the parasite, transfer it to its new habitation and hope that both micro and macro climatic conditions will be favourable to the adjustment of the parasite to its new locality or to its new host, or to both.

As stated in (1), "In the presence of such a multiplicity of causal rela-"tions* it is not an easy matter to determine which of these, if any single one "there be, constitutes the controlling factor, unless, in accordance with Liebig's "law, only one of them reaches the limits of the lethal zone of the organism."

It is not surprising, therefore, that references made in this and other papers to the influence of wind, heat and excess or scarcity of rainfall, are not precise in their nature.

Until it is possible to obtain direct experimental data on the effects of macro and microclimate on the physiology, life cycle and mortality factors of *D. saccharalis*, one's conclusions as to climatic effects, save for instances of extreme demarcation as noted by Wolcott in Peru (9), must necessarily be somewhat vague; which is regrettable because one is thus apt to lose sight of the fact that any biological control measure against *D. saccharalis* is, shall one say, only one colourful piece in the mosaic of any of its biotic patterns, and that the parasite portion of the pattern should be so different in so many *D. saccharalis* areas in the same general longitudinal zone, appears to indicate that meteorological conditions are not inconsiderable factors.

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* Moisture and temperature, rate of evaporation, vapour tension, barometric pressure and air movement, and their effect on insect physiology, reproduction and mortality.

SUMMARY.

1. The study of the rate of *Diatraea* egg deposition, rate of parasitism of eggs by *T. minutum*, extent of destruction of eggs by predators, and extent of total larval mortality at Codrington Experiment Station, Barbados, has enabled some conclusions to be drawn as to the effect of normally wet and abnormally dry conditions on the prevalence of *D. saccharalis* in cane.

2. Abnormal climatic conditions, such as the low rainfall in 1934, are shown to affect—

(a) rate of larval mortality;

(b) effectiveness of the egg parasite *T. minutum*.

(c) to cause a delayed action in the life cycle period of *D. saccharalis*, all of which combine to produce alterations in—

(d) extent of egg deposition of *D. saccharalis*.

Figures on the foregoing points, derived from bi-weekly counts of eggs, parasitism, etc., and a monthly dissection of cane shoots are tabulated for 1933 and 1934, and discussed.

It is also shown that there is a strong possibility that the predator *Atomus* sp., which destroys eggs of *D. saccharalis* in Barbados, is suppressed by soil mulching (which, from its proved value, is being widely adopted in Barbados) quite apart from any effect caused by drought.

3. Although a full solution of the effects of divergent climatic conditions on the prevalence of *D. saccharalis*, or its effect on a crop of altered growth characteristics, cannot be expected from one year's comparison each of wet and dry conditions, and, although several local conditions will affect any experimental records, sufficient data have been obtained to indicate strongly the effect of weather conditions on the different factors which affect *Diatraea* prevalence, and to further the understanding and interpretation of climatic effects on the prevalence of, and damage caused by, *D. saccharalis*.

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